USER MANUAL

RaySafe Xi

RaySafe™

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INTRODUCTION

VERSIONS

This user manual covers the following articles:

Base unit version:	8201011	Detector version:	8202011
	8201021		8202021
	8201013		8202022
	8201023		8202031
			8202040
			8202041
			8202050
			8202060
			8202062
			8202070

This manual discribes the RaySafe Xi which is compatible with the Unfors Xi Platinum Plus version.

ABOUT THIS USER MANUAL

This user manual is intended to assist users in the safe and effective operation of the product described.

Before attempting to operate the product, you must read these instructions for use, noting and strictly observing all WARNINGS and CAUTION notices.

WARNING *A WARNING alerts you to a potential serious outcome, adverse event or safety hazard. Failure to observe a warning may result in death or serious injury to the operator or patient.*

CAUTION *A CAUTION alerts you to where special care is necessary for the safe and effective use of the product. Failure to observe a caution may result in minor or moderate personal injury or damage to the product or other property, and possibly in a remote risk of more serious injury, and/or cause environmental pollution.*

NOTE *Notes highlight unusual points as an aid to an operator.*

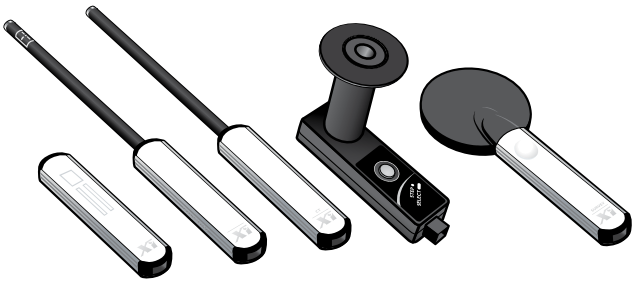
These Instructions for Use describe the most extensive configuration of the product, with the maximum number of options and accessories. Not every function described may be available on your product.

THE RAYSAFE Xi

The RaySafe Xi consists of a base unit and several different external detectors measuring: Radiography/ Fluoroscopy (**R/F**), mammography (**MAM**), on AEC or ABC systems (**Transparent**), Computed Tomography (**CT**), ambient and emitted light (**Light**) and scattered or low level radiation (**Survey**).

Communication between detector and base unit is purely digital, thereby minimizing sensitivity to mechanical or electrical stress. The base unit may also be equipped with an optional integrated tube current meter (**mA/mAs**).

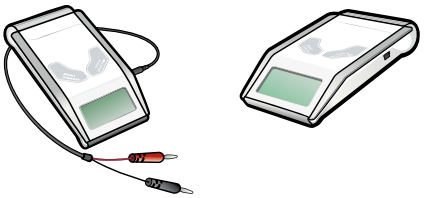
THE RAYSAFE Xi DETECTORS



- The **R/F** detector has two sensors: **R/F high** is designed for conventional, high dose rate measurements normally generated without a phantom between the detector and the X-ray source. **R/F low** is designed for low dose rate measurements normally generated with a phantom between the detector and the X-ray source.
- The **mammography** sensor is used for both low and high dose rates generated in mammography applications.
- The **transparent** detector is a solid-state detector with a very small radiologically visible footprint. It is intended to be used for applications where the **R/F** detector would influence the automatic exposure control on X-ray equipment and serves as a complement to the **R/F** detector. The **transparent** detector is designed to mimic the response of a pancake ion chamber detector and therefore it has no backscatter protection.
- The **CT** detector is an ionization chamber, designed to measure CT dose for applications such as Dose Length Product (DLP) and Computed Tomography Dose Index (CTDI).
- The **light** detector is designed to measure luminance on LCD and CRT monitors, as well as light boxes, and illuminance for diagnostic X-ray applications.
- The **survey** detector is designed for measuring leakage or scattered radiation from X-ray tubes or in examination rooms and leakage radiation from γ-emitting isotopes.

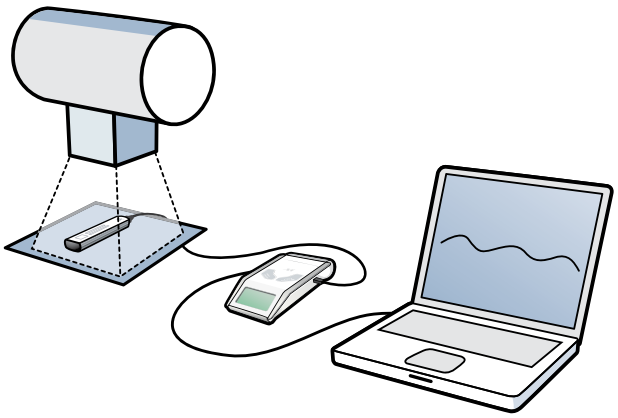
THE RAYSAFE Xi BASE UNIT

There are two versions of the RaySafe Xi base unit: one with and one without **mA/mAs** capabilities. Both versions are fully compatible and interchangeable with the RaySafe Xi detectors as long as the firmware supports the detector (see Specifications). In this manual all information refers to both versions unless otherwise specified.



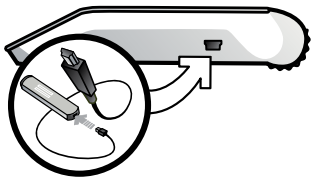
The RaySafe Xi base unit automatically identifies the connected detector and displays the settings and parameters available for that detector.

The built-in active compensation automatically applies corrections for different beam qualities, filtrations and temperatures. During fluoroscopy, survey or light measurements the displayed values are continuously updated. Data is sent on the serial port, and RaySafe Xi view, the program included with your RaySafe Xi, shows numerical data as well as waveforms on a PC.



GETTING STARTED

1. Connect a RaySafe Xi detector of your choice to the RaySafe Xi base unit with one of the two (2 and 10 m) RaySafe Xi cables.



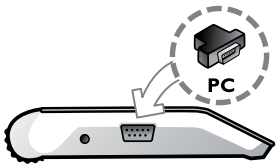
2. Position as required for the selected sensor.
3. Turn on the RaySafe Xi (**ON/OFF** key, see below), and the instrument specific setup information is displayed. In the **SENSOR MENU** a detector or sensor field for your application can be selected.
4. The RaySafe Xi is now in **MEASURE MODE** and ready to measure. Press **STEP** to scroll through measured parameters (also possible during fluoroscopy). The last three displayed parameters will automatically show up after the next exposure. To change setup values (**SETUP MENU**) such as various delays, displayed units and other choices, press **SELECT**.

KEYS ON THE RAYSAFE Xi BASE UNIT

ON/OFF: Turns on the RaySafe Xi and off when in **SENSOR MENU**.
EXIT: Exit to the previous menu.
STEP: A short press steps through available options.
SELECT: A long press selects an option.

TRANSFER DATA TO A COMPUTER

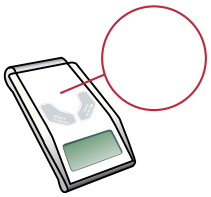
To view the waveform in the RaySafe Xi view and/or transfer measured data to a PC, connect a serial cable or Bluetooth module (option) to the communication port on the RaySafe Xi base unit.



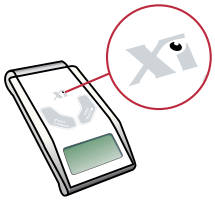
BATTERY AND CHARGER

CAUTION! *Only authorized personnel may remove and replace the battery.*

Fully charge the battery with the provided battery charger before first use. Battery status in percentage is displayed, together with setup information, when the instrument is switched on.



RaySafe Xi/Unfors Xi Platinum Plus



Unfors Xi Platinum

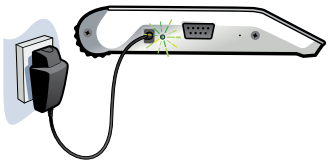
FOR RAYSAFE Xi

The provided battery charger may be connected during all measurements.

FOR UNFORS Xi PLATINUM

The provided battery charger may be connected during measurement except when measuring mAs, as it may create ground currents affecting the measurement. However, the RaySafe Xi battery charger may be connected during all measurements.

Xi version	Battery type	Hours of operation	Charge time
RaySafe Xi	7.4 V Li-ion	20–40 hours	4 hours
Unfors Xi Platinum	9 V NiMH	10–20 hours	15 hours



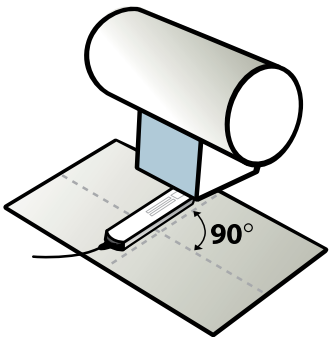
There are two battery warning levels:

- First warning level, “Battery low”: Finish your measurements and then charge the battery.
- Second warning level, “Battery down”: No further measurements are possible.

When the provided battery charger is connected, the external power indicator is lit and **Charging battery** will be briefly displayed. The RaySafe Xi battery will be charged even if the RaySafe Xi is turned off.

There is a battery charger LED indicator that is indicating red while charging and green when the battery is fully charged.

R/F MEASUREMENT



For best accuracy, center the selected sensor field (R/F low or R/F high) and position the long axis of the sensor field perpendicular to the anode-cathode axis of the tube.

1. SENSOR MENU

R/F low	Sensor for conventional low dose rate measurements lower than 1 mGy/s (7 R/min), normally after a phantom.
R/F high	Sensor for conventional high dose rate measurements higher than 1 mGy/s (7 R/min), normally before a phantom.

Press **STEP** to step between sensors and **SELECT** to select a sensor.

2. MEASURE MODE

The displayed values are updated after each exposure, or continuously after 4 seconds of fluoroscopy.

kVp	kVp (for the R/F high sensor at adequate signal levels) or kV
Dose	Gy (Air kerma, free in air) or R (Exposure)
Dose rate	Gy or R per s, m or h
Time	ms, s
HVL	mm Al
Total Filtration, TF	mm Al

Pulses	pulses
Frame rate	frames/s
Dose per frame	Gy or R
mAs	mAs (requires RaySafe Xi base unit with mAs)
mA	mA (requires RaySafe Xi base unit with mAs)

3. SETUP MENU

Press **SELECT** to enter the **SETUP MENU** (from **MEASURE MODE**) and **STEP** to step between setup parameters.

All values are stored in a non-volatile memory and are valid until manually changed. At start up (after the battery status information), valid Trig delay, kVp delay and Calc. delay are displayed in sequence.

(Factory settings in bold.)

Trig delay	A delay in ms after the normal trig of the RaySafe Xi. Utilize when an unwanted part of an exposure, such as a pre-pulse, should be excluded from the measurement. No measurements are performed during the Trig delay. (**0**, 5, 10, 50, 100, 200, 500, 1000, 2000 ms)
Trig level	Use Trig level to measure correct exposure time on waveforms with slowly increasing output, such as with single phase dental. The default setting is a low value, that depends on the selected sensor; see Specifications. Can be set to 25, 50 or 75 % of the peak value of the previous exposure. Use it with the same generator settings and FDD. Not selectable before the first exposure or at low dose rates.
kVp delay	Defined as the delay in ms, after the trig delay, but before the kVp measurement (and waveform) window begins. Use a kVp delay on machines with slow rising output, such as single phase intra oral machines and fluoroscopy systems. (0, 2, **5**, 10, 50, 150, 300, 1000, 1200, 1500, 1700, 2000 ms)
Calc. delay	Defined as the dead time after end trig, before data is calculated. Default is 0.5 s but it is recommended to use a longer delay when measuring on pulsed fluoroscopy where the time between pulses may exceed 0.5 s. (**0.5**, 2, 4, 6, 7 s)

Dose unit	Change the default units and/or use this feature to recalculate a value to a different unit. (Gy or R per s, m or h, where 1 Gy = 114.1 R.)
Backlight	Display lighting option. (off, 2, **5**, 10 s, on)
Auto Power Off	Never, or after 5, **20** or 60 minutes of inactivity.
Info	Displays the serial number (S/N) and firmware version of the connected detector and the RaySafe Xi base unit and the calibration date for the selected sensor. There is also a possibility to reset the instrument settings to factory defaults.
kVp Mode	"kV only" prevents RaySafe Xi from calculating kVp, which otherwise occurs automatically when R/F high is selected and the signal level is high enough ("**kV/kVp**"). Useful for example when measuring near that signal level.

MAMMOGRAPHY MEASUREMENT

Place the detector along the X-ray tube axis (with the cable end pointing towards the X-ray machine). For kV measurements, make sure that the center of the MAM sensor square is placed 6 cm from the examination table front edge. Dose and HVL can be measured from other positions as well.

The following concerns Unfors Xi Platinum, not RaySafe Xi:

NOTE! *When measuring on mammography machines with carbon fibre table, we recommend not to use the power adapter to charge Xi, or use something that creates at least a 5 mm distance between the table and the detector, such as a plastic plate.*

SPECIAL MEASUREMENT CASES

The table below indicates when to use filter for kV measurements.

Beam quality	Filter	Comment
Mo/Mo	No filter	
Mo/Rh	2 mm Al	
W/Rh	No filter	
W/Al 20–39 kV	No filter	
W/Al 40–49kV	2 mm Al	Use the R/F high detector
W/AlScanning	2 mm Al	

Mo/Rh

When measuring **kV with Mo/Rh**, use the included 2 mm Al filter. Follow the instructions printed on the filter.

W/Al Scanning (separate detector)

When measuring kV on W/Al Scanning, use the included 2 mm Al filter. Follow the instructions printed on the filter. Please use the dedicated detector holder. Be sure to push it tight to the examination table front. For more information, see the separate mammography W/Al Scanning Quick Guide (enclosed with the holder).

NOTE! *Some of the scanning W/Al mammography machines have inhomogenous radiation fields. A consequence of this is that the position of the detector is very important. Also, detectors of different viewing angles will result in different dose readings.*

W/Al (Hologic)

To measure kV in the range of 40-49 kV (W/Al), the **R/F MAM** detector and a 2 mm Al filter is needed. Set the detector to **R/F-high** (see R/F Measurement). When measuring in Combo mode on Hologic Selenia Dimensions 3D, use the sensor menu choice “Combo” and 7 s Calc. delay (located in the Setup Menu).

1. SENSOR MENU

Mammography	Sensor for mammography measurements with submenu for selection of beam qualities, see list to the right (depending on configuration). The choice of “paddle” or “no paddle” **only** applies if the kV measurement is going to be made with or without a paddle in the beam and does not affect dose or HVL measurements.	Mo/Mo No Paddle Mo/Mo Paddle Mo/Rh Mo/Al Rh/Rh Rh/Al W/Rh No Paddle W/Rh Paddle W/Rh* No Paddle W/Rh* Paddle W/Ag W/Al S (scanning) W/Al No Paddle W/Al Paddle Combo

NOTE! *Select W/Rh* for measurements on Hologic Selenia and Planmed Nuance. W/Al (scanning) is on a separate detector.*

2. MEASURE MODE

The displayed values are updated after each exposure.

kV	kV (Mo/Mo, optional: Mo/Rh, W/Rh, W/Al and W/Al scanning)
Dose	Gy (Air kerma, free in air) or R (Exposure)
Dose rate	Gy or R per s, m or h
Time	ms, s
HVL	mm Al
mAs	mAs (requires RaySafe Xi base unit with mAs)
mA	mA (requires RaySafe Xi base unit with mAs)

3. SETUP MENU

Press **SELECT** to enter the **SETUP MENU** (from **MEASURE MODE**) and **STEP** to step between setup parameters.

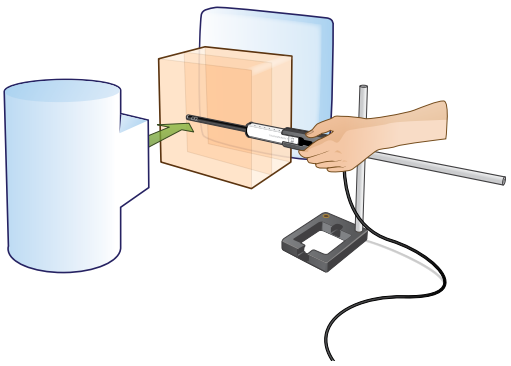
All values are stored in a non-volatile memory and are valid until manually changed. At start up (after the battery status information), valid Trig delay, kVp delay and Calc. delay are displayed in sequence.

(Factory settings in bold.)

Trig delay	A delay in ms after the normal trig of the RaySafe Xi. Utilize when an unwanted part of an exposure, such as a pre-pulse, should be excluded from the measurement. No measurements are performed during the Trig delay. (**0**, 5, 10, 50, 100, 200, 500, 1000, 2000 ms)
Trig level	Use Trig level to measure correct exposure time on waveforms with slowly increasing output, such as with single phase dental. The default setting is a low value, that depends on the selected sensor; see Specifications. Can be set to 25, 50 or 75 % of the peak value of the previous exposure. Use it with the same generator settings and FDD. Not selectable before the first exposure or at low dose rates.
kVp delay	Defined as the delay in ms, after the trig delay, but before the radiation and kV waveform window (in the RaySafe Xi view) begins. (0, 2, **5**, 10, 50, 150, 300, 1000, 1200, 1500, 1700, 2000 ms)
Calc. delay	Defined as the dead time after end trig, before data is calculated. Default is 0.5 s but it is recommended to use 2 s when measuring on generators with a pre-pulse. (**0.5**, 2, 4, 6, 7s)

Dose unit	Change the default units and/or use this feature to recalculate a value to a different unit. (Gy or R per s, m or h, where 1 Gy = 114.1 R)
Backlight	Display lighting option. (off, 2, **5**, 10 s, on)
Auto Power Off	Never, or after 5, **20** or 60 minutes of inactivity.
Info	Displays the serial number (S/N) and firmware version of the connected detector and the RaySafe Xi base unit and the calibration date for the selected sensor. There is also a possibility to reset the instrument settings to factory defaults.

TRANSPARENT MEASUREMENT



Position the detector with the sensor towards the X-ray source.

1. SENSOR MENU

Transparent	Sensor for measurements on systems with automatic exposure control.

Press **STEP** to step between sensors and **SELECT** to select a sensor.

2. MEASURE MODE

The displayed values are updated after each exposure, or continuously after 4 seconds of fluoroscopy.

Dose	Gy (Air kerma, free in air) or R (Exposure)
Dose rate	Gy or R per s, m or h
Time	ms, s
Pulses	pulses
Frame rate	frames/s
Dose per frame	Gy or R

3. SETUP MENU

Press **SELECT** to enter the **SETUP MENU** (from **MEASURE MODE**) and **STEP** to step between setup parameters.

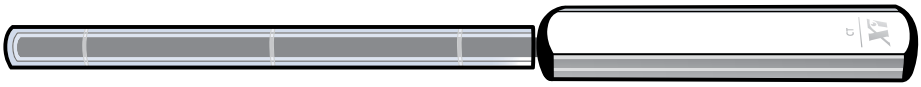
All values are stored in a non-volatile memory and are valid until manually changed. At start up (after the battery status information), valid Calc. delay is displayed.

(Factory settings in bold.)

Calc. delay	Defined as the dead time after end trig, before data is calculated. Default is 0.5 s but it is recommended to use a longer delay when measuring on pulsed fluoroscopy where the time between pulses may exceed 0.5 s. (**0.5**, 2, 4, 6, 7 s)
Dose unit	Change the default units and/or use this feature to recalculate a value to a different unit. (Gy or R per s, m or h, where 1 Gy = 114.1 R.)
Backlight	Display lighting option. (off, 2, **5**, 10 s, on)
Auto Power Off	Never, or after 5, **20** or 60 minutes of inactivity.
Info	Displays the serial number (S/N) and firmware version of the connected detector and the RaySafe Xi base unit and the calibration date for the selected sensor. There is also a possibility to reset the instrument settings to factory defaults.

CT MEASUREMENT

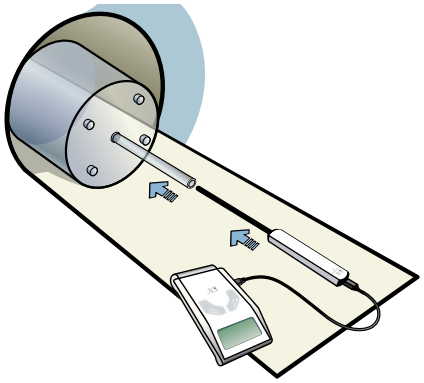
The RaySafe Xi CT detector is an ion chamber with a 10 cm active length and a built-in bias voltage. The center and the edges (+ 5 cm and - 5 cm) of the active volume are marked on the phantom adapter.



An automatic correction of temperature and pressure will be applied for all dose measurements. The temperature sensor is positioned inside the active ionization chamber and the measurement is corrected for the true temperature inside the phantom. The pressure sensor is placed inside the RaySafe Xi CT detector housing and is calibrated to show the actual pressure at the measurement facility's altitude. Readings of pressure can therefore vary from announcements in newspapers or web sites, which normally refer to the pressure at sea level. The measured temperature and pressure for each exposure can be displayed when using the RaySafe Xi view.

HOW TO MEASURE CT DOSE

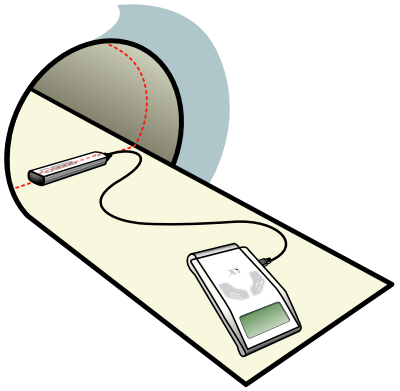
Position the RaySafe Xi CT detector in the phantom adapter and then into the phantom position. Turn on the meter and select CT dose.



For positioning of the RaySafe Xi CT detector free in air, Unfors RaySafe recommends the use of the RaySafe Flexi stand.

HOW TO MEASURE CT kVp

Position the RaySafe Xi R/F detector along the CT beam slice. Turn on the meter and select R/F high. Expose without rotation i.e. in scout/tomogram/topogram mode, using no or slowest table movement.



1. SENSOR MENU

CT Dose	Ion chamber sensor

Press **STEP** to step between sensors and **SELECT** to select a sensor.

NOTE! *When turning on the RaySafe Xi base unit with the RaySafe Xi CT detector connected, "Stabilizing" will be displayed for a few seconds while the electronics are stabilizing.*

2. MEASURE MODE

After an offset adjustment, the RaySafe Xi is in **MEASURE MODE**. The displayed value is updated after each exposure.

Dose	Gy (Air kerma, free in air) or R (Exposure)
Dose Length Product	Gycm or Rcm

NOTE! *The RaySafe Xi CT detector can be used in two dose modes (dose or dose length product (DLP)), selectable in the* **SETUP MENU**. *Since the RaySafe Xi CT chamber is 10.0 cm long, DLP readings (in Gy•cm or R•cm) will always be exactly 10 times higher than dose readings.*

3. SETUP MENU

Press **SELECT** to enter the **SETUP MENU** (from **MEASURE MODE**) and **STEP** to step between setup parameters.

All values are stored in a non-volatile memory and are valid until manually changed.

(Factory settings in bold.)

Dose unit	Change the default units and/or use this feature to recalculate a value to a different unit. (Dose: Gy, Gycm, R or Rcm, Temperature: °F or °C, Pressure: kPa or mmHg)
Backlight	Display lighting option. (off, 2, **5**, 10 s, on)
Auto Power Off	Never, or after 5, **20** or 60 minutes of inactivity.
Info	Displays the serial number (S/N) and firmware version of the connected detector and the RaySafe Xi base unit and the calibration date for the selected sensor. There is also a possibility to reset the instrument settings to factory defaults.

Temperature and pressure values are shown only in the RaySafe Xi view, not on the RaySafe Xi base unit display.

Dose	600,7 µGy
Temperature	22,48 °C
Pressure	97,46 kPa

LIGHT MEASUREMENT

The RaySafe Xi light detector is designed to measure luminance on LCD and CRT monitors, as well as light boxes, and illuminance for diagnostic X-ray applications.

The choice between luminance and illuminance is automatic depending on whether the luminance tube is mounted or not.

1. SENSOR MENU

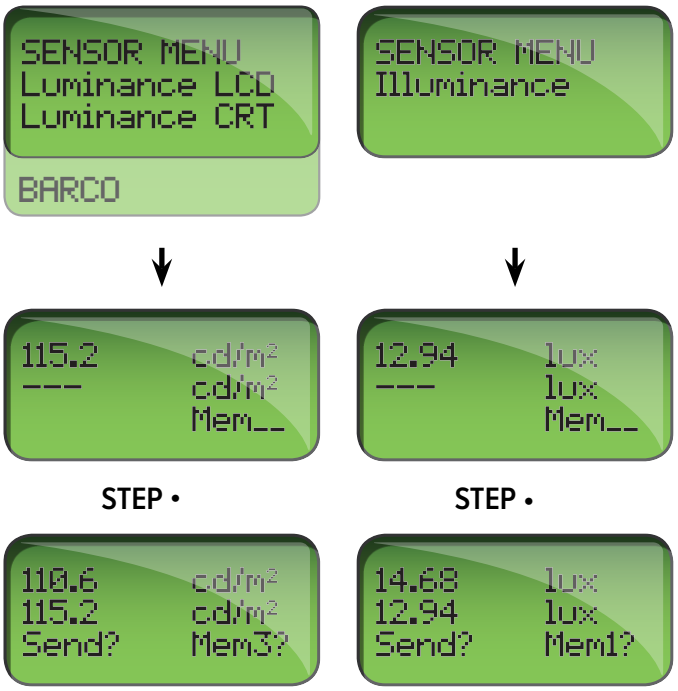
Illuminance	For illuminance measurements.
LuminanceLCD	For luminance measurements on LCD.
LuminanceCRT	For luminance measurements on CRT display, light box or similar.
Barco	For luminance measurements on Barco monitor. MFGD 5621 HD, MDMG 5121, MFGD 5421, MDCG 3120, MDCG 2121 or MFGD 3621.

Press **STEP** to step between sensors and **SELECT** to select a sensor.

2. MEASURE MODE

Luminance	cd/m² or fL
Illuminance	lux or fc

Press **STEP** when in **MEASURE MODE** to freeze and move the measured value to the second line of the display. A new press on **STEP** will move a new measured value to the second line of the display. Store the measured value (and send it via the RS-232 interface) in the RaySafe Xi memory by pressing **SELECT**. A memory counter (**Mem #**) will be displayed at the very bottom of the display.



3. SETUP MENU

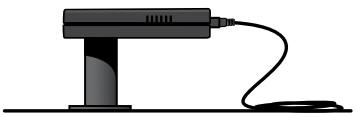
Press **SELECT** to enter the **SETUP MENU** (from **MEASURE MODE**) and **STEP** to step between setup parameters.

All values are stored in a non-volatile memory and are valid until manually changed.

(Factory settings in bold.)

Offset adjustment	To ensure the highest level of accuracy, RaySafe recommends performing a manual offset adjustment when making luminance measurements below 2 cd/m^2 or when making illuminance measurement below 1 lux. Cover the sensor before performing the offset adjustment.
Reset memory	Resets the memory of 30 luminance or 30 illuminance measurements depending on the selected sensor. The reset is only available if data has been stored in the memory.
Send memory	Sends the complete data memory of the current sensor via the RS-232 interface. This choice is only available if data has been stored in the memory.
Unit	Change the default units and/or use this feature to recalculate a value to a different unit. (**cd/m^2** and **lux**, or fL and fc)
Backlight	Display lighting option. (off, 2, **5**, 10 s, on)
Auto Power Off	Never, or after 5, **20** or 60 minutes of inactivity.
Info	Displays the serial number (S/N) and firmware version of the connected detector and the RaySafe Xi base unit and the calibration date for the selected sensor. There is also a possibility to reset the instrument settings to factory defaults.

HINT! *Mount the luminance tube and shadow ring. Then position the light detector on a flat and solid surface (like a table) and perform the offset adjustment.*



SURVEY MEASUREMENT

The RaySafe Xi survey detector is designed for measuring leakage or scattered radiation from X-ray equipment and γ-emitting isotopes.

Available dose quantities (selectable from **SETUP MENU**) are:

- Air kerma (K_{air}), in Gy
- Exposure (X), in R
- Ambient dose equivalent (H*(10)), in Sv

1. SENSOR MENU

R/F	For leakage or scatter from R/F equipment.
Mammography	For leakage or scatter from mammography equipment.
Nuclear Med.	When measuring on γ-emitting isotopes.

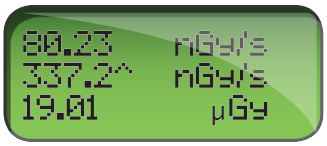
After an offset adjustment, the detector waits in **IDLE MODE**. Start measuring by a short press on the RaySafe Xi survey detector key.

2. MEASURE MODE

In **MEASURE MODE** the ticker frequency is proportional to current dose rate. Measured values are continuously updated on the display (twice per second).

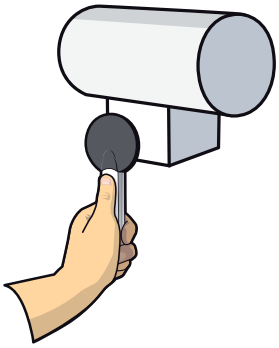
Dose rate	Gy, R or Sv per s, m or h
Dose rate, peak (^)	Gy, R or Sv per s, m or h
Accumulated dose	Gy, R or Sv

While in measure mode, a short press on the detector key stops measurement.



Displayed in **MEASURE MODE**	Displayed in **IDLE MODE**
instantaneous dose rate	*average dose rate*
peak dose rate (^)	*peak dose rate (^)*
accumulated dose	*accumulated dose*

A long press on the detector key induces a new offset adjustment, and the instrument returns to **IDLE MODE**.



3. SETUP MENU

Press **SELECT** to enter the **SETUP MENU** (from **MEASURE MODE**) and **STEP** to step between setup parameters.

All values are stored in a non-volatile memory and are valid until manually changed.

(Factory settings in bold.)

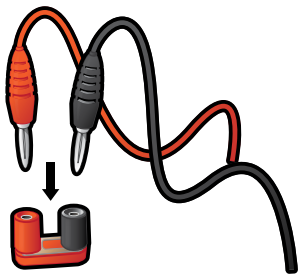
Dose unit	Change the default units and/or use this feature to recalculate a value to a different unit. (Gy, R or Sv per s, m or h, where 1 Gy = 114.1 R.)

Sound	Off, **On**
Backlight	Display lighting option. (off, 2, **5**, 10 s, on)
Auto Power Off	Never, or after 5, **20** or 60 minutes of inactivity.
Info	Displays the serial number (S/N) and firmware version of the connected detector and the RaySafe Xi base unit and the calibration date for the selected sensor. There is also a possibility to reset the instrument settings to factory defaults.

mA/mAs MEASUREMENT

Follow the steps below to start mA/mAs measurement:

1. Turn off the X-ray generator.
2. Remove the jumper of the mA/mAs port in the generator.
3. Connect the mAs cable to the RaySafe Xi base unit.
4. Connect the black and red banana plugs of the RaySafe Xi mAs cable to the mA/mAs port of the generator. (Note! The RaySafe Xi mA/mAs instrument is dependent on the polarity. Using the wrong polarity will result in no trig.)
5. Switch on the X-ray generator.
6. Turn on the RaySafe Xi and select mA/mAs in the **SENSOR MENU**. Make an exposure and read the measurements in the display.



CAUTION! *Do not forget to replace the mA/mAs jumper when removing the RaySafe Xi mAs cable.*

CAUTION! *Users of the RaySafe Xi mA/mAs meter must be aware of the potential damage to generators and electrical human hazards in case of improper connection or failure of any part of the meter circuit. This feature is intended for use only by personnel authorized in performing calibration and repair of X-ray equipment.*

1. SENSOR MENU

mA/mAs	Circuitry for invasive measurements of mA, mAs, time, pulses, frame rate, mAs/pulse (the RaySafe Xi base unit with mAs only).

2. MEASURE MODE

After an offset adjustment, the RaySafe Xi is in **MEASURE MODE**. The displayed values are updated after each exposure or continuously after 4 seconds of fluoroscopy.

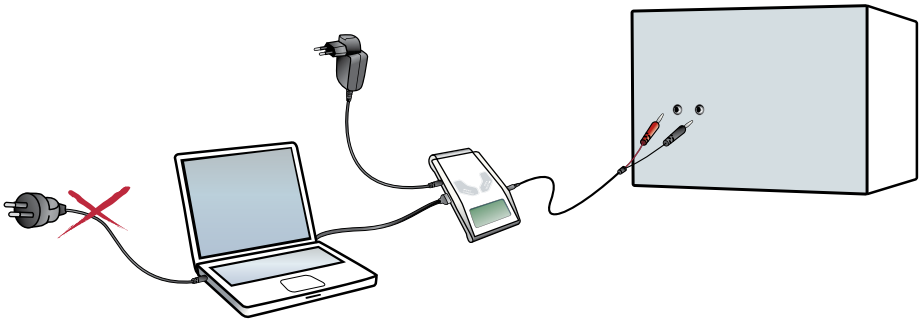
mAs	mAs
mA	mA
Time	ms, s
Pulses	pulses
Frame rate	frames/s
mAs per frame	mAs/f

3. SETUP MENU

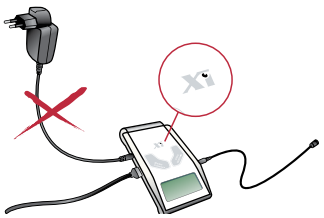
Press **SELECT** to enter the **SETUP MENU** (from **MEASURE MODE**) and **STEP** to step between setup parameters.

When in the **SETUP** menu, the active selection will blink. All values are stored in a non-volatile memory and are valid until manually changed. At start up (after the battery status information), valid Trig delay and Calc. delay are displayed in sequence. (Factory settings in bold.)

Trig delay	A delay in ms after the normal trig of the RaySafe Xi. Utilize when an unwanted part of an exposure, such as a pre-pulse, should be excluded from the measurement. No measurements are performed during the Trig delay. (**0,** 5, 10, 50, 100, 200, 500, 1000, 2000 ms)
Calc. delay	Defined as the dead time after end trig, before data is calculated. Default is 0.5 s but it is recommended to use a longer delay when measuring on pulsed fluoroscopy where the time between pulses may exceed 0.5 s. (**0.5**, 2, 4, 6 s)
Backlight	Display lighting option. (off, 2, **5**, 10 s, on)
Auto Power Off	Never, or after 5, **20** or 60 minutes of inactivity.
Info	Displays the serial number (S/N) and firmware version of the detector and the RaySafe Xi base unit and the calibration date for the selected sensor. There is also a possibility to reset the instrument settings to factory defaults.

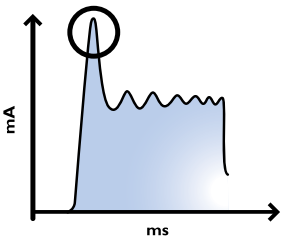


NOTE! *Use a laptop operating on battery or a Bluetooth connection when capturing waveforms or transferring data to a computer running RaySafe Xi view. Connection of a PC (mains supplied) via a serial cable to the RaySafe Xi base unit may create ground currents affecting the measurement.*



For Unfors Xi Platinum: *Also avoid connecting the Unfors Xi battery charger when measuring mA/mAs, as it may create ground currents affecting the measurement. However, the RaySafe Xi battery charger may be connected during all measurements.*

Be aware of rush currents (loading the capacitance in the high voltage cables) in the initial part of the exposure. Use a Trig delay of 5 ms in the **SETUP MENU** to exclude the rush current from the measurement, if desired.



PASSIVE mAs

It is possible to measure mAs simultaneously with other measurements with an RaySafe Xi R/F or mammography detector connected. The instrument will trig on radiation, not on the current in the RaySafe Xi mAs cable. Any initial rush current will thus be excluded. The measured mAs value automatically appears in **MEASURE MODE** on the display.

On some X-ray equipment the tube current does not drop below 25% of peak at the end of the exposure or the generator give a second current pulse within 0.5 ms. The result is a long time measurement which gives a low mA calculation. These situations are suitable for passive mAs. Follow the steps below to measure passive mAs:

1. Connect the R/F or MAM detector to the RaySafe Xi.
2. Connect the mAs cable to the RaySafe Xi base unit.
3. Connect the black and red banana plugs of the RaySafe Xi mAs cable to the mA/mAs port of the generator.
4. Place the R/F or MAM detector in the X-ray field.
5. Make the exposure.

MEASUREMENT DEFINITIONS

Figure 1 illustrates the RaySafe Xi parameter definitions available on a typical waveform. In most situations the default settings are suitable for accurate measurements. In certain situations advanced users can change the measuring definitions of the RaySafe Xi by activating Trig delay and/or Trig level settings. Because the measured parameters will be affected by the settings of delays and trig levels, it is recommended to note the setup information shown on the RaySafe Xi base unit display at power on.

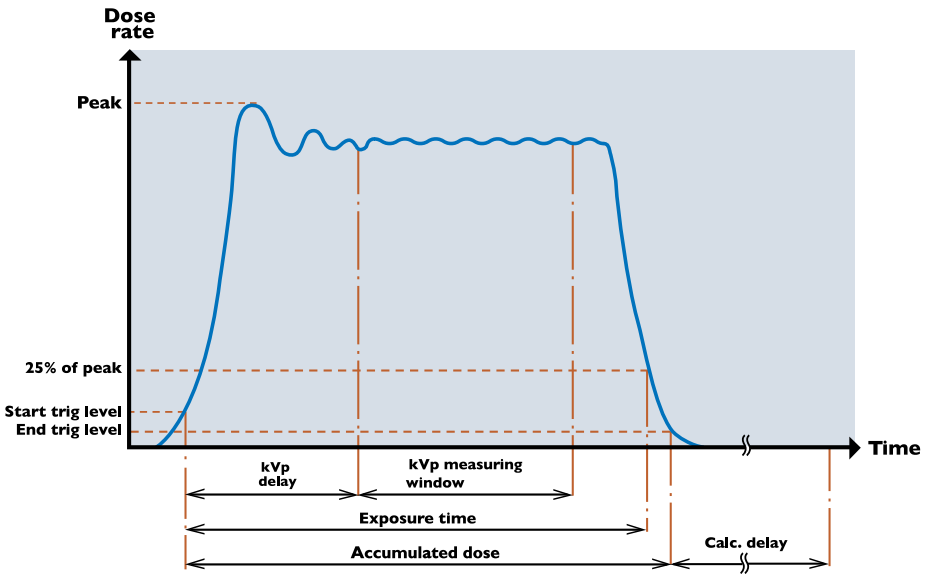


Figure 1. Normal Measurement

When an exposure exceeds 4 seconds the measured values are continuously updated in the display. It may take another few seconds to get stable readings (synchronized with the frame rate).

DOSE

The dose is accumulated from the start trig point plus Trig delay until the end trig.

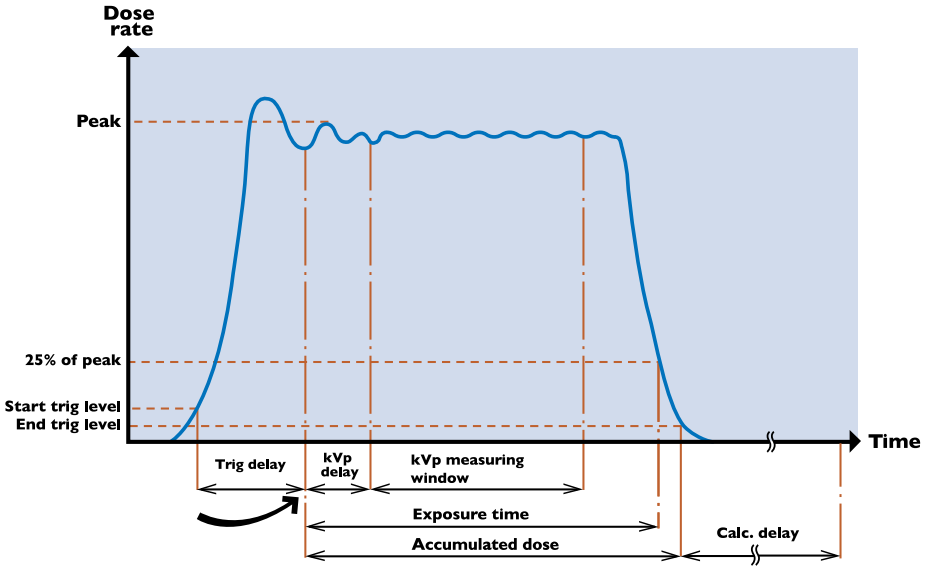


Figure 2. Trig delay activated

NOTE! *The trig level setting (25, 50 or 75 %) affects the dose measurement.*

NOTE! *The backscatter protection of the RaySafe Xi R/F detector may cause differences in readings compared to ion chambers. If both are placed directly against an object, i.e. image receptor or lead apron, the RaySafe Xi R/F detector will read lower compared to an ion chamber. However the RaySafe Xi R/F detector will be reading True Input Dose while the ion chamber is reading the input dose plus back scatter from the object directly behind it. If using the RaySafe Xi R/F detector and an ion chamber in free air they should be comparable ± both meter tolerances.*

The RaySafe Xi R/F detector measures dose with a multi-segment sensor, and the Active compensation feature automatically corrects the displayed dose (and dose rate) for beam qualities with an HVL of 1 – 14 mm Al (for example: a filtration of 45 mm Al at 140 kVp gives an HVL of about 13 mm Al).

For mammography the active compensation corrects the dose for selected beam quality with an added filtration of up to 2.5 mm Al (not valid for the W/Al Scanning detector).

The RaySafe Xi transparent detector measures dose with a multi-segment sensor, and the Active compensation feature automatically corrects the displayed dose and dose rate for beam qualities with an HVL of 2 – 10 mm Al.

The CT meter is an ionization chamber with carbon fiber housing. It has a flat energy dependence curve and automatic pressure and temperature correction.

DOSE RATE

The RaySafe Xi calculates dose rate as ***dose/exposure time*** if the exposure time is less than 6 seconds.

After an exposure longer than 6 seconds, a dose rate value recorded approximately 2 seconds before end trig will be displayed.

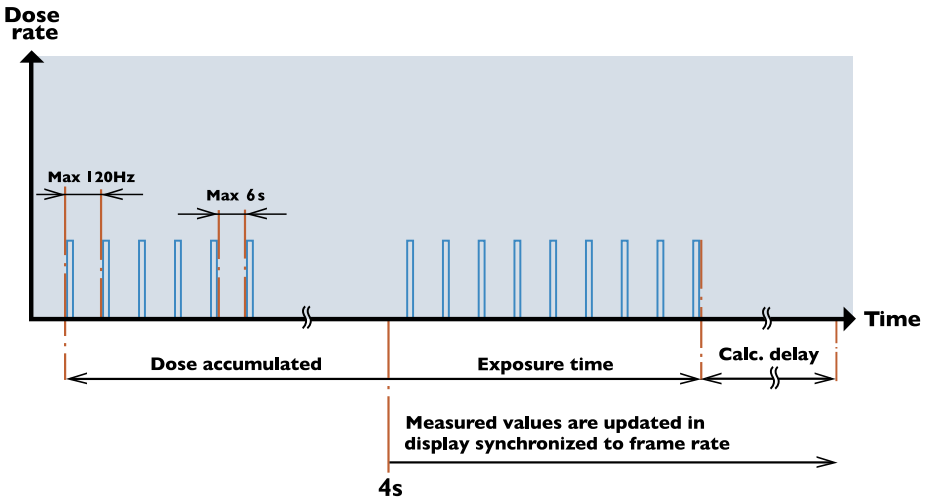


Figure 3. Pulsed fluoroscopy

kV/kVp

The RaySafe Xi calculates kVp on the R/F high sensor if the signal level is high enough, otherwise kV average will be displayed. If no kVp value is displayed, try decreasing the FDD or increasing mA.

kVp is calculated within the kVp measuring window. The kVp measuring window begins after Trig delay and kVp delay and is approximately 160 ms wide.

If the exposure time is less than 6 seconds, kV average is the integrated average of the kV values during the whole measurement.

After an exposure longer than 6 seconds, a kV value recorded approximately 2 seconds before end trig will be displayed.

After the exposure, kV (or kVp if available) is displayed and a waveform is transmitted to the RaySafe Xi view. The RaySafe Xi view also gives a possibility to increase the length of the waveform window.

kVp matches kV on high frequency or DC like waveforms. If there is a ripple on the waveform, a kV value will be lower than kVp.

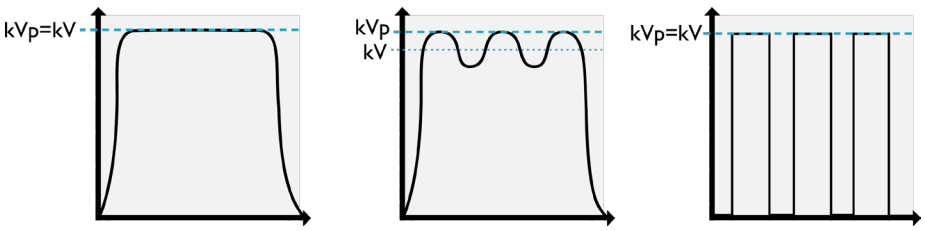


Figure 4. kV and kVp

Table: Active compensation on kV measurements

Sensor	Filtration	kV/kVp
R/F low	Max. 1 mm Cu or equivalent	kV
R/F high	Max. 1 mm Cu or equivalent	kVp (when signal level is high enough)
Mammography:		
Mo/Mo	25 – 35 µm Mo	kV (choose “paddle” or “no paddle”)
Mo/Rh	25 – 30 µm Rh	kV (use 2mm Al filter)
W/Rh	55 – 60 µm Rh	kV (choose “paddle” or “no paddle”)
W/Al	0.65 – 0.75 mm Al	kV (choose ”paddle” or ”no paddle”)
W/Al S (scanning)	0.5 mm Al total filtration	kV (use 2mm Al filter)

Use a kVp delay on machines with a slow rising output. 150 ms on dental single phase machines and 1000 ms on a fluoroscopy machine is recommended.

kV is available for R/F and mammography detectors.

NOTE! *When selecting the Mo/Mo W/Rh, or W/Al mammography beam quality, you also get at choice of “paddle” or “no paddle” which* ***only*** *applies if the kV measurement is going to be made with or without a paddle in the beam and does not affect dose or HVL measurements.*

TIME

The RaySafe Xi measures time from the start trig (may be adjusted with the Trig level setting) until the signal falls below 25 % of the peak (50 or 75 % if adjusted with the Trig level setting). At low dose rates (about 1 % of the max dose rate for the active sensor), the 25 % end level is changed to a low level (about the lowest measurable dose rate for the active sensor).

If the radiation has a pulsed characteristic, the time is measured until the last pulse ends. The dead time interval between pulses must, however, be less than the Calc. Delay time (0.5, 2, 4, 6 or 7 s). The R/F low sensor has an electrical bandwidth of 0.1 kHz (slower rising and falling slopes), causing the displayed exposure time to be a few milliseconds longer than for the R/F high sensor, which has a bandwidth of 2.5 kHz.

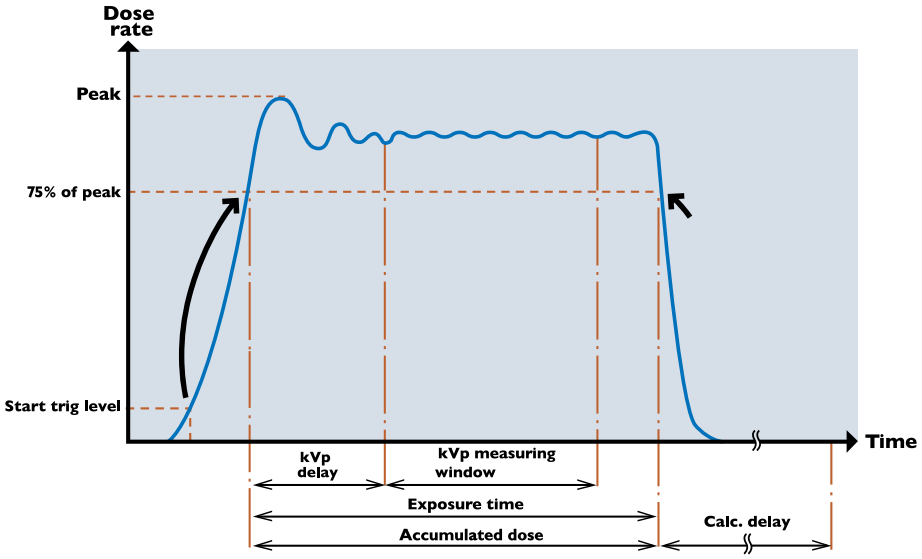


Figure 5. 75 % trig level activated (figure also applies to 25 and 50 % trig level settings). Please note that the trig level setting affects the dose measurement.

Single phase generators (normally dental applications) may have slowly increasing amplitude characteristics for approximately 100 ms. It is then recommended to activate a higher trig level in the **SETUP MENU** after the first exposure.

PULSE

The RaySafe Xi counts pulses from 1 to 9999. The trigger to increment the pulse counter occurs when the dose rate has a negative slope and the amplitude falls below 25 % of the peak amplitude for the exposure. At peak dose rates of approximately < 3 µGy/s (for R/F low) the signal to noise ratio is too low to count pulses and "---" will be displayed. If possible, increase the mA and/or kVp to increase the radiation output or decrease the FDD.

Pulse is available for the R/F and mA/mAs detectors.

FRAME RATE

The RaySafe Xi calculates frame rate as: ***(number of pulses -1)/(exposure time in seconds).*** If pulses can not be counted, the frame rate can not be calculated (see Pulse section above).

For exposures longer than 4 seconds, the frame rate is continuously calculated as ***(number of pulses since last update)/(time since last update).*** It may take another few seconds to get stable readings.

Frame rate is available for the R/F and mA/mAs detectors.

DOSE PER FRAME

The RaySafe Xi calculates Dose per Frame as (accumulated dose)/(number of pulses). If pulses can not be counted, the Dose per Frame can not be calculated.

Dose per Frame is available for the R/F and mA/mAs detectors.

HVL (HALF VALUE LAYER)

The RaySafe Xi calculates HVL as a function of the signals from several sensor elements from the whole exposure, if exposure time is less than 6 seconds.

If the exposure is longer than 6 seconds, a HVL value recorded approximately 2 seconds before end trig will be displayed.

HVL is an indication of the beam quality and is defined as the amount of Al filtration, measured in mm, needed to reduce the dose in half. HVL is kVp dependent. HVL should not be confused with total filtration.

HVL is available for R/F and mammography detectors.

TOTAL FILTRATION

Total filtration is a calculation of the amount of physical filtration between the X-ray source and the patient, expressed in equivalent amount of mm Al.

The total filtration value measured may differ from the filtration stated by the X-ray manufacturer, as there might be additional filtration not specified by the manufacturer.

mA AND mAs

The RaySafe Xi base unit with mAs is capable of measuring mA, mAs and time. If the peak mA is > 8 mA, it can also measure pulses, frame rate and mAs per pulse.
When an exposure longer than 6 seconds has ended, a mA value recorded approximately 2 s before end trig is displayed.

RAYSAFE Xi VIEW

RaySafe Xi view is suitable for

- viewing waveforms
- storing measurements
- transferring data to Excel or other software

NOTE! *The latest version of RaySafe Xi view is available on http://www.RaySafe.com*

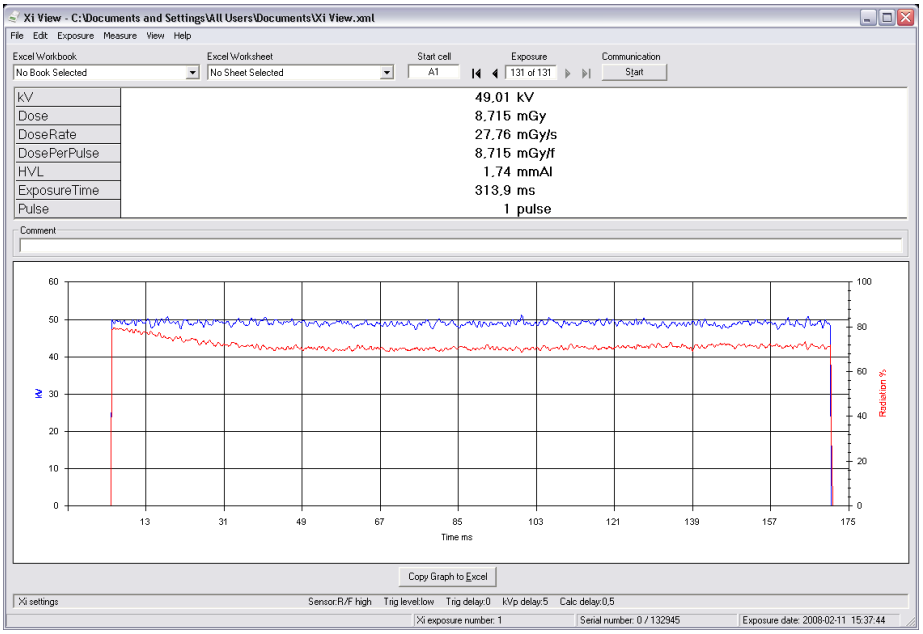


Figure 6. RaySafe Xi view main window.

INSTALLING RAYSAFE Xi VIEW

The RaySafe Xi is delivered with a Resource CD which contains the RaySafe Xi view software. Insert the CD in a PC and a menu will appear for installation. If the installation menu doesn't appear, the RaySafe Xi view can be installed from the CD by accessing the "FSCommand" folder and select "Install Xiview.exe". The software is compatible with Windows 7, Windows Vista, Windows XP, Windows 2000 and Windows 98SE.

During the installation you will be asked if you want to install a driver for the USB serial port adapter. If your laptop is not equipped with a serial port and you intend to use a USB to serial adapter, please check the box to install the driver.

There are two ways for the RaySafe Xi to communicate with a PC:

Via the RS-232 cable to the PC. If the PC has only USB ports, the supplied standard adapter converting RS-232 to USB must be used.

Via a Bluetooth module connected directly to the RaySafe Xi serial port. A PC with built-in or external USB Bluetooth normally works after the required setup procedure.

SETUP OF BLUETOOTH COMMUNICATION

1. Follow the instructions enclosed with the PC's internal or external Bluetooth device.
2. Insert the Bluetooth module into the RaySafe Xi base unit's RS-232 port and turn on the base unit.
3. Go to the Bluetooth icon in the Windows Control Panel. Select a menu called "Add Bluetooth device" or similar.
4. The PC will scan for available Bluetooth devices and will find "Xi slave". Add this device.
5. When prompted enter the passkey for the Xi slave which is ***"1234".***
6. The installation procedure will finish. Please note the number of the COM port assigned to the instrument.
7. Start RaySafe Xi view and go to File – Settings and enter the correct COM port. Press the Start button and "Started waiting for data" will appear in the bottom left corner of the screen.
8. Go to the **SETUP MENU** of the instrument and select the **INFO** option. Scroll until "Xi view test" appears and press **SELECT**. Test data should now appear on the RaySafe Xi view screen.

GETTING HELP

A complete manual for RaySafe Xi view can be found in the Help menu.

ACCESSORIES

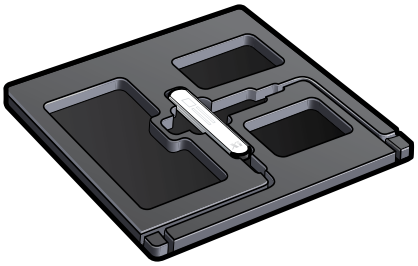
THE RAYSAFE Xi FLEXI STAND

The RaySafe Xi Flexi stand can be used in many different ways. Assemble it to fit your needs.

THE RAYSAFE Xi CASSETTE HOLDER

The RaySafe Xi Cassette holder can be used for measuring dose to film or when checking the exposure control, e.g. AEC systems.

The holder is 24 x 30 cm (10 x 12 in) and makes it possible to measure on all three AEC chambers at once, without repositioning the detector.



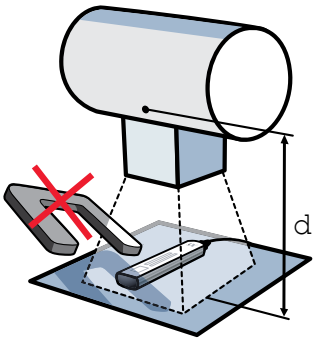
Put the RaySafe Xi R/F detector in the holder and place the holder with the detector perpendicular to the anode-cathode axis of the tube and expose. (You may need to turn the holder to cover up the right area below the AEC chambers.)

TIPS AND TRICKS

ARRANGEMENT OF MEASUREMENT

Make sure nothing is in the X-ray field when measuring with the RaySafe Xi.

The fact that the dose is proportional to $1/d^2$ (where d is the FDD – Focus to detector Distance) may be used when positioning the sensor.



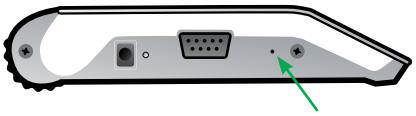
SENSOR POSITION

The solid state sensors in the RaySafe Xi R/F and mammography detector are positioned approximately 7 mm beneath the detector surface. The position is marked with a line on the aluminium housing. This position is used as a calibration reference point for dose.

In the RaySafe Xi transparent detector, the white rectangle marks the position of the solid state sensor. The depth is marked by the longitudinal sides of the white rectangle, as can been seen in the picture.

RESET SWITCH

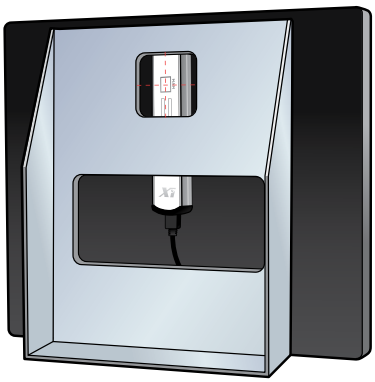
If the software hangs up, by any reason, activate the system reset by pressing a thin object through the small hole beside the RS-232 connector on the side of the RaySafe Xi base unit.



If the detector hangs up when the battery is down and does not respond even when a charger is connected, reset as described above and charge for some minutes before turning the instrument on again.

VERTICAL DETECTOR PLACEMENT

When measuring on a mammography machine with a horizontal beam, such as MultiCare Platinum, let the pressure from the compression paddle fix the RaySafe Xi mammography detector in position. Put the detector with the cable end pointing downwards and with the MAM-window centered in the compression paddle biopsy window, as shown below.



kVp ON AMX

When measuring on AMX machines with R/F high, keep a short distance to get kVp instead of kV.

DISPLAY CODES

Display	Meaning
* * *	Measurement has started.
- - -	No value can be calculated.
< 1 ms	Less than 1 ms valid samples.

Display	Meaning
LoSignal	The dose rate is too low to calculate a value (increase mA or decrease FDD).
HiSignal	The dose rate is too high to calculate a value (increase FDD or decrease mA).
LoRange	Calculated parameter is less than specified range.
HiRange	Calculated parameter has exceeded specified range.
t<delay	The exposure time is not long enough to calculate a value.
Ofl.	Overflow, i.e. calculated value is numerically higher than can be displayed.
Auto range out of order	At least one of the measuring ranges is out of order.
Offset adjustment out of range	Hardware offset levels may be out of range due to extreme temperatures.
Offset out of range	Ionization chamber current fails to reach a stable level when the RaySafe Xi CT detector is turned on.
LokV	The kV is too low to calculate the total filtration.
HikV	The kV is too high to calculate the total filtration.
HiFilt	The filtration is too high to measure the parameter.
Battery down	The battery must be charged before any measurements can be made.
Detector is incompatible	The connected detector is not compatible with the RaySafe Xi base unit version.

FREQUENTLY ASKED QUESTIONS

What is the difference between R/F high and R/F low, and how do I use them?

R/F low is optimized for low signal levels, typically found during fluoroscopy, behind a phantom. It has a high sensitivity at the cost of a lower bandwidth (0.1 kHz) and should be used at dose rates below approximately 1 mGy/s.

R/F high is optimized for higher signal levels and features a higher bandwidth (2.5 kHz). It is typically used before a phantom, and is required for measuring kVp (as opposed to kV).

What is the difference in dose and dose length product in a CT application?

Dose is basically a property of a point in space, while dose length product (DLP) is dose times a length. When measuring with a 100 mm ionization chamber the following holds true: *DLP = (Measured dose in a point and assuming a homogenous field) • (Slice Width).*

When using the RaySafe Xi CT it is possible to change between Dose and DLP by selecting Dose Unit as Gy or Gycm in the settings menu.

How do I switch between kV and kVp?

The RaySafe Xi switches to kVp automatically, as soon as the signal level is high enough (but only when using R/F high). For high frequency generators, the difference between kV and kVp will be negligible.

In comparison to an ion chamber, the RaySafe Xi shows lower values, why?

The RaySafe Xi R/F or mammography detector only measures the primary beam, not scattered radiation, because the back of the detectors shielded with 1 mm of lead. The detector may therefore be placed on any surface and still measure true air kerma.

Most ionization chambers measure primary as well as scattered radiation, which is why they should be placed free in air (at least 0.5 m (2 ft) from any scattering material). When used in such fashion, the RaySafe Xi will show similar readings when compared to an ion chamber.

What is the difference between the "paddle" and "no paddle" setting in the mammography sensor menu?

This setting selects between two different kV calibrations. It does not affect any other measurement, such as dose, HVL or time.

- Why do I not get a kV reading when choosing beam qualities other than Mo/Mo (and optional: Mo/Rh, W/Rh and W/Al) for mammography?

As far as we know, all mammography devices have at least one of the above mentioned beam qualities. To calibrate the RaySafe Xi for measuring kV on other beam qualities would thus result in unnecessary complexity and a higher calibration cost.

What happens if the mA/mAs cable is connected with the wrong polarity?

The RaySafe Xi will not show any mA/mAs readings. As long as the mA/mAs cable is securely connected to both generator and base unit (in any polarity), there is no increased risk of damaging the generator or the Xi.

Can I use the transparent detector for the same applications as the CT detector?

No, the transparent detector do not measure radial radiation.

Why are the HVL and the total filtration sometimes the same value and sometimes not?

HVL depends on kV, while the total filtration value depends on the physical filtration in the X-ray equipment. Therefore the HVL and the total filtration are not dependent on each other and may sometimes be equal and sometimes not.

Why is the total filtration sometimes different from the flitration stated by the X-ray manufacturer?

This may be caused by the 10 % uncertaincy in the measurement of the total filtration or by additional filtration not included in the filtration specification given by the X-ray manufacturer.

TROUBLESHOOTING

When turned on, the RaySafe Xi briefly shows "Battery down" and refuses to start.

Please charge the battery, see chapter Getting Started.

Values do not show up in RaySafe Xi view.

Make sure that all cables are properly connected and that you have:

- established a Bluetooth connection (password 1234).
- selected the correct COM port in file/settings menu of RaySafe Xi view.
- pressed on the RaySafe Xi view Start button.

The RaySafe Xi shows only half of the expected mAs value.

If you are measuring on a generator with AC signal on the mAs measurement point, you will need a rectifier (optional) to get correct values.

When the RaySafe Xi with CT detector is turned on, the instrument displays "Offset out of range" after displaying "Stabilizing..." for a long time.

This means that the ionization chamber current fails to reach a stable level when the instrument is turned on. Please make sure that:

- the chamber is not irradiated during stabilization or offset adjustment.
- you are not operating the instrument outside its specified temperature range.

If the problem persists, your instrument might be in need of a repair. Please contact RaySafe Service department.

I get "Offset adjustment out of range".

Make sure that:

- you are not operating the instrument outside its specified temperature limits.
- you are not irradiating the detector during the offset adjustment phase (when values on display are blinking).

When used with pulsed sources it may be necessary to select a longer Calc. delay to avoid end trig and offset adjustment during the measurement (see also next problem).

The RaySafe Xi R/F or mammography detector end trigs during exposure.

Make sure to select an appropriate Calc. delay if using the instrument with pulsed generators, or with generators having a pre-pulse before the main exposure.

The RaySafe Xi does not respond when pressing keys.

Try the reset switch and make sure that the battery is charged.

I get strange mA/mAs readings when I'm using the RaySafe Xi's AC adaptor or when my computer is connected to mains power.

Make sure that the instrument

- was connected to the generator during offset adjustment.
- is operating on battery (no AC adaptor).
- is *not* connected to a grounded computer (use Bluetooth or a laptop running on batteries with no Ethernet cable connected).

I get too low readings with my RaySafe Xi light.

If the illuminance sensor is dirty, please clean it using a slightly dampened cloth.

I get strange readings when measuring HVL on mammography, in comparison with my manual HVL measurements.

Please make sure that the thickness of your Al filters is accurately known. A resolution on the order of 1 µm is needed for 0.1 mm thickness.

I get strange readings when using the transparent detector.

Please make sure that the sensor is positioned towards the X-ray source.

WARRANTY, SERVICE AND SUPPORT

Unfors RaySafe warrants to the original product purchaser that each product it manufactures will be free from defects in material and workmanship under normal use and service. The warranty period is 12 months and begins on the date of delivery. Unfors RaySafe will at its option, repair or replace the defect product free of charge or refund your purchase price. If it is determined that the failure was caused by misuse, alteration, accident or abnormal condition of operation or handling, the customer will be billed for the repair and the repaired product will be returned to you, transportation prepaid. This warranty is exclusive and is in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose or use. Unfors RaySafe will not be liable for any special, indirect, incidental, or consequential damages or loss of data, whether in contract, tort, or otherwise.

SERVICE

Unfors RaySafe offers you service which includes calibration, repair, warranty and accessories. In case your RaySafe Xi fails, our service staff will assist in the expeditious repair and return of your product. Our normal service handling time is 14 days.

The RaySafe Xi Service Program allows you to minimize the cost of your RaySafe Xi over its product life cycle and to keep the instrument in top functioning condition. Unfors RaySafe offers an annual, full service repair and calibration facility at our two service centers, one located in Sweden for international customers and one in the United States for North and South American customers.

The RaySafe Xi Service Program offers a 12 month extended warranty after annual calibration and service. After 5 years from the date of purchase, the extended warranty is no longer offered.

A participant of the RaySafe Xi Service Program is obligated to return the RaySafe Xi annually, with a 12 month cycle (± 1 month) based on the original delivery date. Failure to do so will void any part of the RaySafe Service Program.

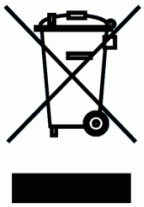
RETURN PROCEDURE FOR SERVICE AND WARRANTY

Any unit returned to Unfors RaySafe for service must be accompanied by a completed RaySafe Service Request Form which can be downloaded from www.RaySafe.com. If you do not have access to the internet, please contact us and we will send you a copy (see Contacts below).

Unfors RaySafe highly recommends you send us a completed RMA (Return Material Authorization) request before returning your instrument. Please note that we cannot guarantee a specified turn-around time if an RMA is not issued.

DISPOSAL

The Directive on Waste Electrical and Electronic Equipment (WEEE)



This symbol, found on the product or on its box, indicates that this product must not be disposed of or discarded with normal household waste. All electronic or electrical waste equipment must be sent to a recycling center designated for such hazardous waste. Proper disposal of your electronic and electrical waste equipment will help us to conserve our natural resources. Moreover, proper recycling of electronic and electrical waste equipment will help to ensure human safety and the health of the environment. For more information about electronic and electrical waste equipment disposal, recovery and collection points, please contact your local city government, your household waste disposal service, the place of purchase, or the manufacturer of the equipment.